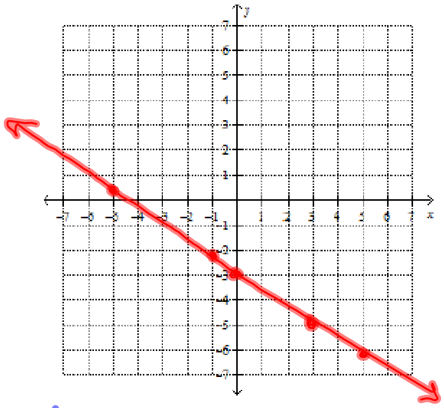
Given below are tables of values for different functions. Classify each function by type. Sketch a graph of the function. Then, state as many specific properties, including the equation if possible, of each function as you possibly can.

1.

x	-5	-1	0	3	5	9
$F(x)$	$\frac{1}{3}$	$-\frac{7}{3}$	-3	-5	$-\frac{19}{3}$	-9



Linear

Slope: $-\frac{2}{3}$

y-int: -3

$y = -\frac{2}{3}x - 3$

D: $(-\infty, \infty)$

R: $(-\infty, \infty)$

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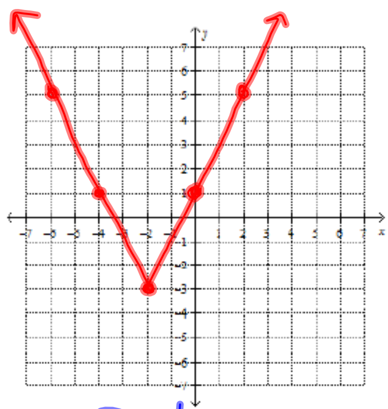
2.

x	-6	-4	-2	0	2	4
$G(x)$	5	1	-3	1	5	9



Absolute Value

$y = 2|x+2| - 3$

Left 2

Down 3

D: $(-\infty, \infty)$

R: $[-3, \infty)$

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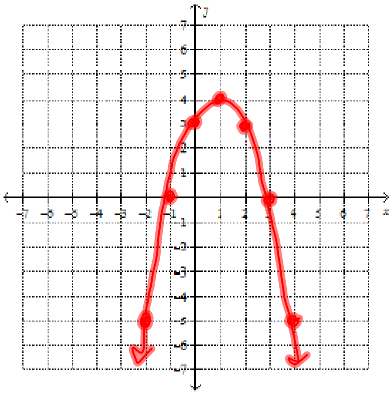
3.

x	-2	-1	0	1	2	3	4
$H(x)$	-5	0	3	4	3	0	-5



Quadratic

Zeros: $x=-1$ $x=3$

$y=-(x-1)^2+4$ or

$y=-x^2+2x+3$

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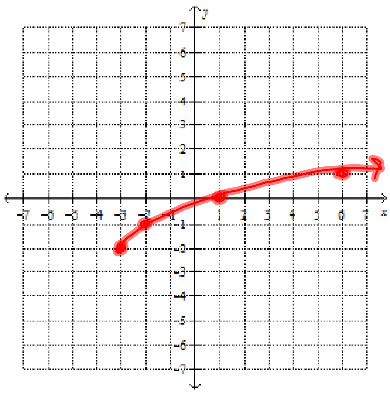
4.

x	-4	-3	-2	1	6	13
$J(x)$	Undefined	-2	-1	0	1	2



Square Root or Radical

$y=\sqrt{x+3}-2$

D: $[-3,\infty)$
R: $[-2,\infty)$

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5.

x	−6	−3	−1	0	2	4	6	10
$K(x)$	3.0156	3.125	3.5	4	7	19	67	1027

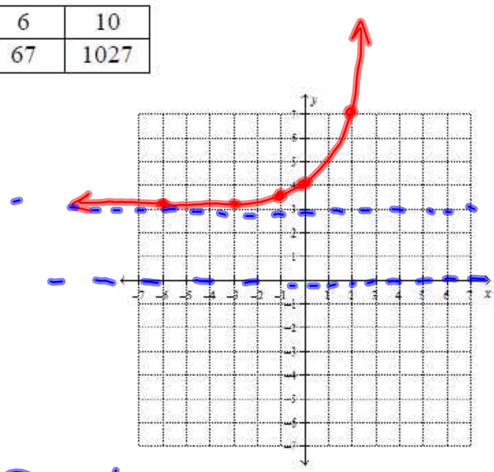
Exponential Growth

2^x

e^x

$y = 2^x + 3$

HA: $y = 3$



D: $(-\infty, \infty)$

R: $(3, \infty)$

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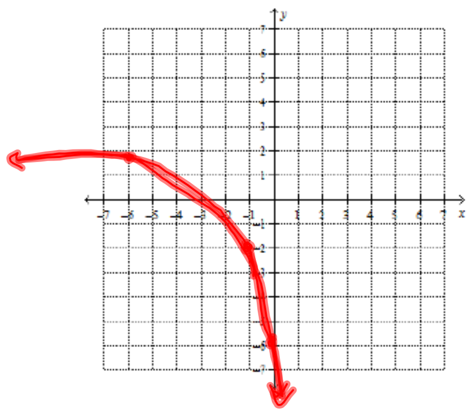
6.

x	−11	−6	−1	0	2	4	6	10
$M(x)$	1.996	1.875	−2	−6	−30	−126	−510	−8190

Exponential Decay



$y = -8(2^x) + 2$

upside do

up 2

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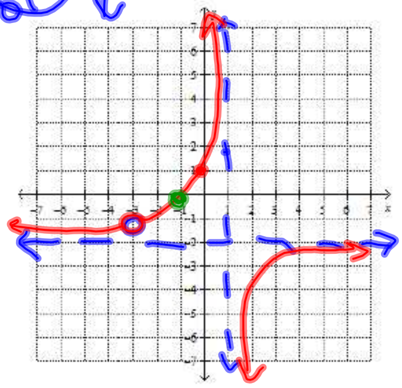
7.

(x+3) (x-1)

x	-1000	-3.001	-3	-2.999	0	0.999	1	1.001	1000
$N(x)$	-1.997	-1.250	Undefined	-1.249	1	2998	Undefined	-3002	-2.003

Hole

Asymptote $x=1$



Rational

HA: $y=-2$

HA, x-int, Hole

$$y = \frac{-2(x+1)(x+3)}{(x+3)(x-1)}$$

Hole, VA

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$$y = \frac{-2(x+1)\cancel{(x+3)}}{\cancel{(x+3)}(x-1)} \rightarrow y = \frac{-2(x+1)}{x-1}$$

To find x-int: Set $y=0$

$$(x-1)\cdot 0 = \frac{-2(x+1)}{\cancel{x-1}}\cdot\cancel{x-1}$$

$$0=-2(x+1)$$

$$0=x+1$$

$$\boxed{-1=x}$$

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HA

$D_{Top} < D_{Bot}$ HA: $y=0$

$D_{Top} = D_{Bot}$ HA: $y=$ Leading Coefficients

$D_{Top} > D_{Bot}$ No HA

May have SA

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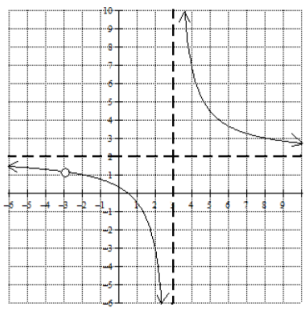
The equation of the function graphed to the right is $f(x)=\frac{2x^2+5x-3}{x^2-9}$. The coordinates of the hole in the graph are $\left(-3,\frac{7}{6}\right)$.



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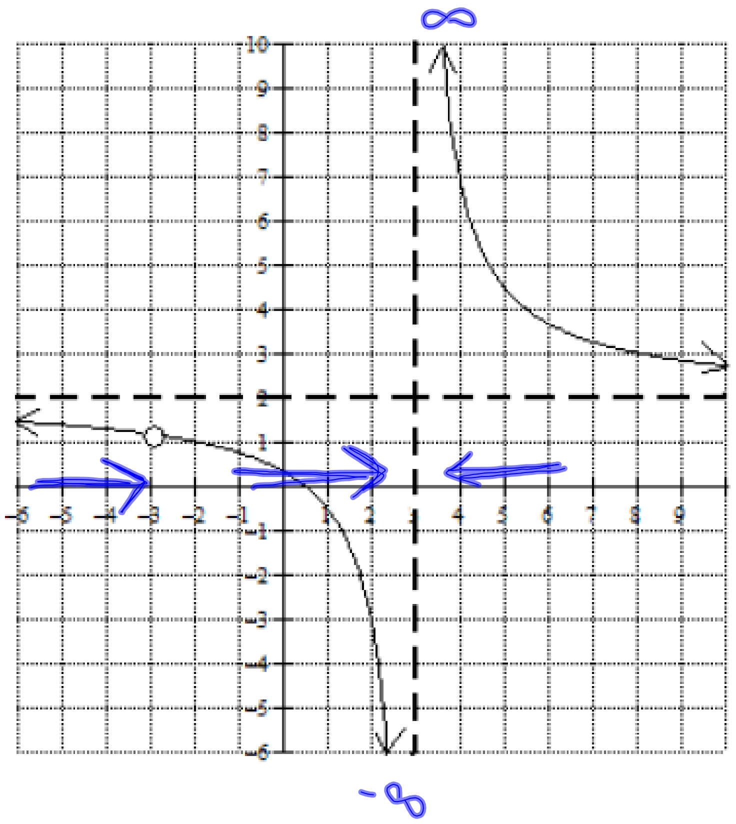

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"approaches"

Pre-calculus Statements

As $x \to -\infty$, the graph of $f(x) \to$ <u>2</u>.

As $x \to \infty$, the graph of $f(x) \to$ <u>2</u>.

Calculus Limit Notation

$$\lim_{x \to -\infty} f(x) = 2$$

$$\lim_{x \to \infty} f(x) = 2$$

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As $x \to -3$ from the left, the graph of $f(x) \to$ $\underline{7/6}$.	$\lim_{x \to -3^-} f(x) = 7/6$
As $x \to -3$ from the right, the graph of $f(x) \to$ $\underline{7/6}$.	$\lim_{x \to -3^+} f(x) = 7/6$
As $x \to 3$ from the left, the graph of $f(x) \to$ $\underline{-\infty}$.	$\lim_{x \to 3^-} f(x) = -\infty$
As $x \to 3$ from the right, the graph of $f(x) \to$ $\underline{\infty}$.	$\lim_{x \to 3^+} f(x) = \infty$

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Based on what you have just seen, how might you informally define what the value of a limit represents in terms of the graph?

$\lim_{x \to a} f(x)$ is the y-value that the graph approaches as x approaches a.

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A Numerical Analysis of Limits

- Now let's consider the function $f(x)=\frac{(2x^2+5x-3)}{(x^2-9)}$
- Complete the table to below to perform a numerical analysis of the function as $x \to -\infty$ and ∞.

$-\infty \leftarrow$ $\rightarrow \infty$

x	−1000	−500	−100	−50	50	100	500	1000
$f(x)$	1.995	1.990	1.951	1.906	2.106	2.052	2.010	2.005

$2 \leftarrow$ $\rightarrow 2$

Based on the values in the table, what are the values of

$$\lim_{x\to-\infty}\frac{2x^2+5x-3}{x^2-9}=2 \qquad \lim_{x\to\infty}\frac{2x^2+5x-3}{x^2-9}=2$$

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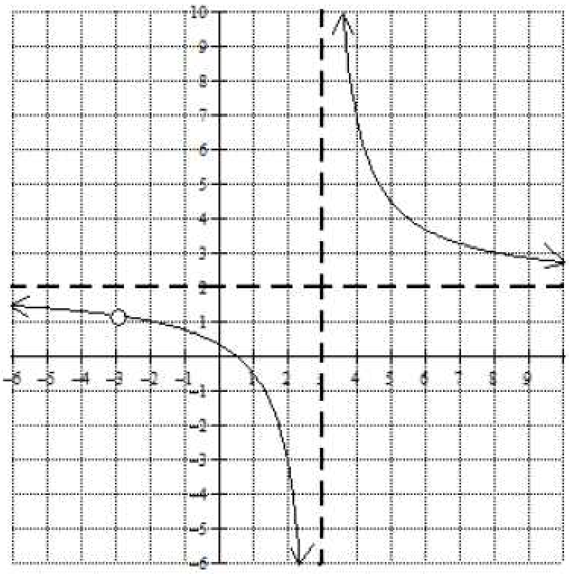
How is the numerical analysis above related in the graph of the function pictured below?



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A Numerical Analysis of Limits

- Now let's consider the function $f(x)=\dfrac{2x^2+5x-3}{x^2-9}$
- Complete the table to below to perform a numerical analysis of the function as $x \rightarrow -3$ from the left and from the right.

$\rightarrow -3 \leftarrow$

x	−3.75	−3.1	−3.01	−3.001	−2.999	−2.99	−2.9	−2.75
$f(x)$	1.259	1.180	1.168	1.167	1.167	1.165	1.153	1.130

Based on the values in the table, what are the values of

$$\lim_{x\to -3^-}\frac{2x^2+5x-3}{x^2-9} = 1.167 \qquad \lim_{x\to -3^+}\frac{2x^2+5x-3}{x^2-9} = 1.167$$

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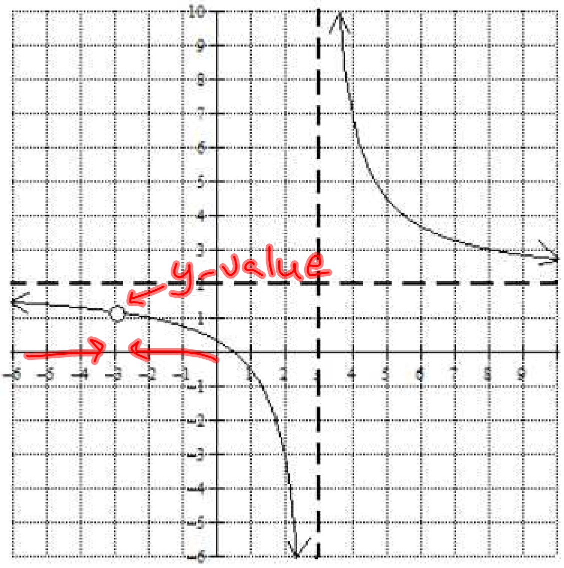
How is the numerical analysis above related in the graph of the function pictured below?

1.167 or 7/6



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A Numerical Analysis of Limits

- Now let's consider the function $f(x)=\dfrac{2x^2+5x-3}{x^2-9}$
- Complete the table to below to perform a numerical analysis of the function as $x \to 3$ from the left and from the right.

$\longrightarrow 3 \longleftarrow$

x	2.75	2.9	2.99	2.999	3.001	3.01	3.1	3.75
$f(x)$	-18	-48	-498	-4998	5002	502	52	8.667

Based on the values in the table, what are the values of

$$\lim_{x\to 3^-}\frac{2x^2+5x-3}{x^2-9} = -\infty \qquad \lim_{x\to 3^+}\frac{2x^2+5x-3}{x^2-9} = \infty$$

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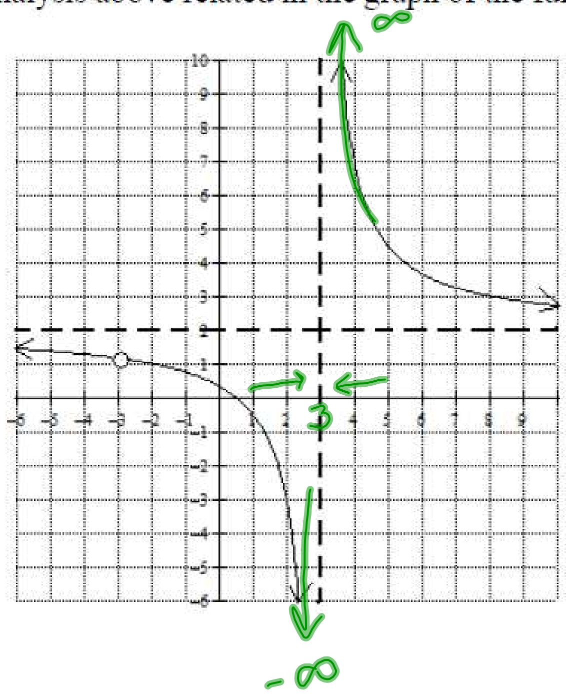
How is the numerical analysis above related in the graph of the function pictured below?



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Limit Existence Theorem

$\lim_{x\to a} f(x)$ exists iff $\lim_{x\to a^-} f(x) = \lim_{x\to a^+} f(x) = b$

where b is any REAL number.

if and only if

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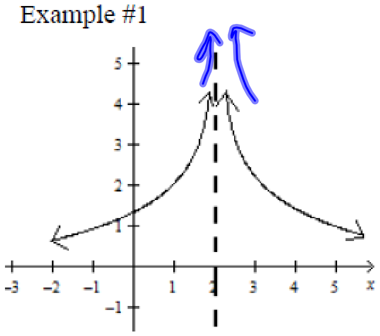
Limits That Do Not Exist

Example #1



Find each of the following from the graph.

a) $\lim_{x\to 2^-} f(x) = \infty$

b. $\lim_{x\to 2^+} f(x) = \infty$

c) $f(2) =$ undefined

d) Does $\lim_{x\to 2} f(x)$ exist or not? Why or why not?

$\lim_{x\to 2} f(x)$ DNE

b/c ∞ is not a REAL number

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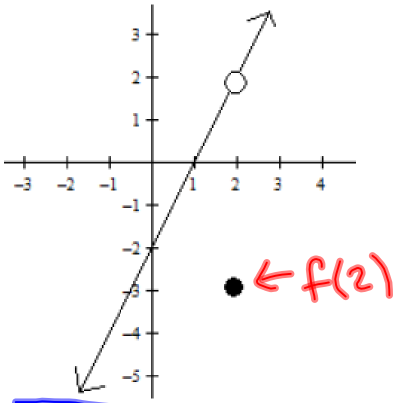
Example #2



Find each of the following from the graph.

a) $\lim_{x\to 2^-} f(x) = 2$ b. $\lim_{x\to 2^+} f(x) = 2$

c) $f(2) = -3$

d) Does $\lim_{x\to 2} f(x)$ exist or not? Why or why not?

Yes the limit exists b/c $\lim_{x\to 2^-} f(x) = \lim_{x\to 2^+} f(x)$

$$\boxed{y = \begin{cases} 2x-2 & x \neq 2 \\ -3 & x = 2 \end{cases}}$$

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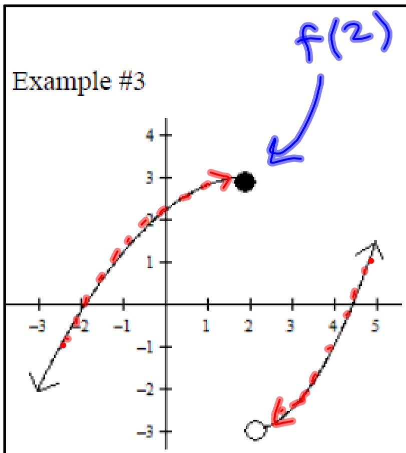
Example #3



Find each of the following from the graph.

a) $\lim_{x\to 2^-} f(x) = 3$ b. $\lim_{x\to 2^+} f(x) = -3$

c) $f(2) = 3$

d) Does $\lim_{x\to 2} f(x)$ exist or not? Why or why not?

No, the $\lim_{x\to 2} f(x)$ DNE b/c

$\lim_{x\to 2^-} f(x) \neq \lim_{x\to 2^+} f(x)$

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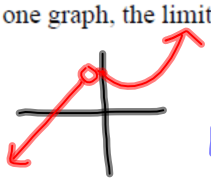
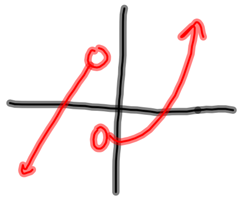
Based on what you have seen so far, does $f(a)$ have to be defined in order for the $\lim_{x\to a} f(x)$ to exist? Draw and explain two different graphs to justify your reasoning. In both graphs, $f(a)$ should be undefined but in one graph, the limit should exist while in the second one, it should not exist.



$f(a)$ is undefined but $\lim_{x\to a}$ still exists.

point discontinuity



$f(a)$ is undef. but $\lim_{x\to a} f(x)$ DNE.

jump discontinuity

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Below is a table of values of an exponential function. Use the table to find the limits that follow.

$\to \infty$

x	-9	-5	-3	-1	1	3	9
$f(x)$	513	33	9	3	1.5	1.125	1.002

a) $\lim_{x\to-\infty} f(x) = \infty$

b) $\lim_{x\to-3} f(x) = 9$

c) $\lim_{x\to1} f(x) = 1.5$

d) $\lim_{x\to\infty} f(x) = 1$

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Below is a table of values of a rational function. Use the table to find the limits that follow.

x	-1000	-1.001	-1	-0.999	0	1.999	2	2.001	1000
$F(x)$	1.002	2001	Undefined	-1999	-1	0.333	Undefined	0.334	0.998

VA

a) $\lim_{x \to -\infty} f(x) = 1$

b) $\lim_{x \to -1^-} f(x) = \infty$

c) $\lim_{x \to -1^+} f(x) = -\infty$

d) $\lim_{x \to 2} f(x) = 1/3$

e) $\lim_{x \to \infty} f(x) = 1$

f) $\lim_{x \to -1} f(x) = \text{DNE}$

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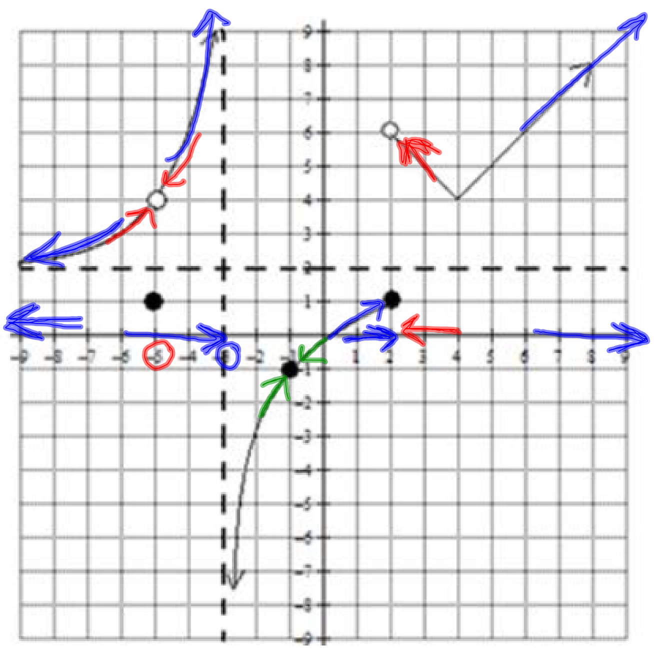

$f(-5) = 1$

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Using the graph, find the value of each of the following limits. If a limit does not exist, state why.

a) $\lim_{x\to -3^-} f(x)$

∞

b) $\lim_{x\to -5} f(x)$

4

c) $\lim_{x\to -1} f(x)$

-1

c) $\lim_{x\to -3} f(x)$

DNE

d) $\lim_{x\to 2^-} f(x)$

1

e) $\lim_{x\to 2^+} f(x)$

6

f) $\lim_{x\to 2} f(x)$

DNE

$\lim_{x\to 2^-} f(x) \neq \lim_{x\to 2^+} f(x)$

g) $\lim_{x\to -\infty} f(x)$

2

h) $\lim_{x\to \infty} f(x)$

∞

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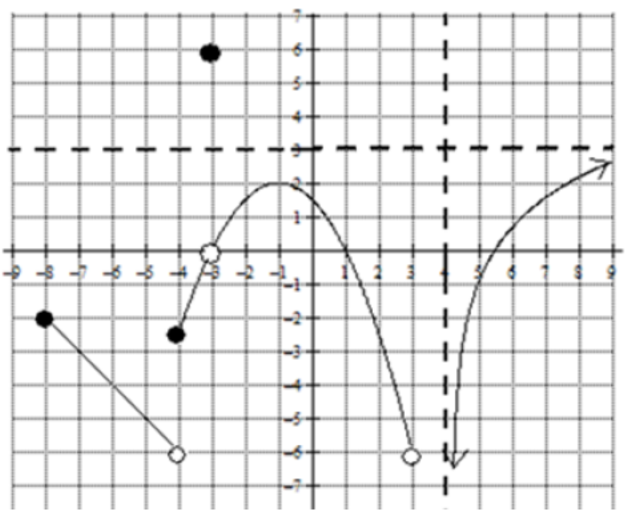

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a) $\lim_{x \to -3^-} g(x)$ b) $\lim_{x \to -6} g(x)$ c) $\lim_{x \to -1^+} g(x)$

d) $\lim_{x \to -3^+} g(x)$ e) $\lim_{x \to 4^-} g(x)$ f) $\lim_{x \to 4^+} g(x)$

g) $\lim_{x \to 4} g(x)$ h) $\lim_{x \to -4^+} g(x)$ i) $\lim_{x \to -4^-} g(x)$

Completed as Exit Ticket

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